VISIT…

The Best Materials Scientists - Indians

Professor E. S. Dwarakadasa

Retd. Professor of Metallurgy, IISc.

CEO and MD, Karnataka Hybrid Micro Devices Ltd.

Distinguished Professor, RVCE, Bangalore

- "Many of the advances in the sciences that we consider today to have been made in Europe were in fact made in India centuries ago."

  Grant Duff
  British Historian of India

Materials

- Mud
- Stone
- Minerals
- Metals
- Alloys
- Wood

- Temples
- Edifices
- Depiction of Gods
- Animals
- Mementoes

A Stupa Built of Bricks and Mud

Look at the beautiful terracotta flower vase. The lighting effect from different angles makes it more beautiful. Though not crafted very intricately but this flower vase has a different charm in its simplicity. The curves and the designs at the top are fascinating

A Memorial Built of Bricks and Mortar

Temple car - Wooden

The Rashtrakutas produced the Kailasa temple at Ellora. Badami has four cave temples executed at various levels of the sand stone hill.

Basava in stone Monolithic There are more than a 100 in the country. The largest I supposed to be the one in Lepakshi

Temples bear the best testimony for the prowess in using a natural material like stone

An Intricate Stone Sculpture

Thousand Pillar Hall and Details on one of the Pillars

Yali, Hall of 1000 Pillars

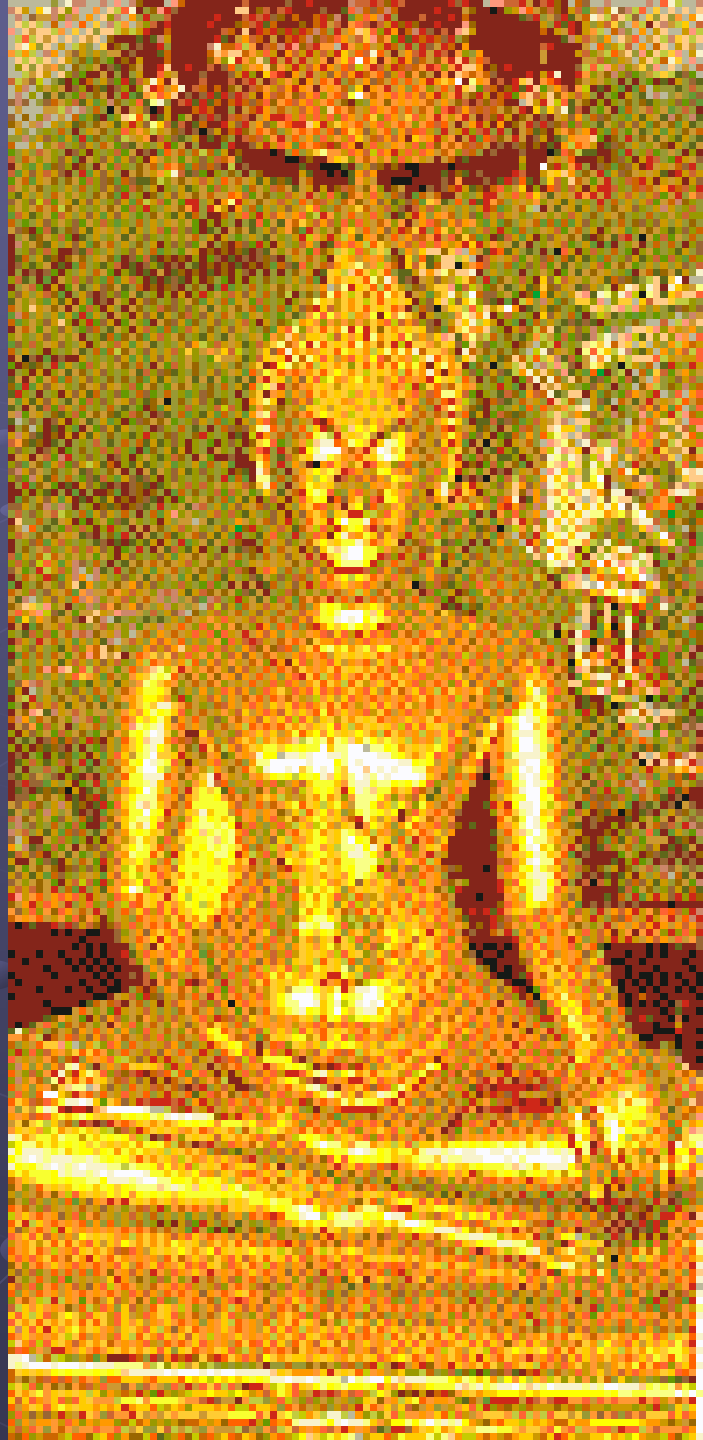
Hall of Thousand Pillars Sri Meenakshi Temple, Madurai

Belur Temple (Karnataka)

- The earliest recorded use of copperware in India has been around 3000 B.C. the findings at Mohen-jo-daro and Harappa, bear this out. The earliest documented observation of smelting of metals in India is by Greek Historians in the 4th Century B.C

- the Periplus refers to the "muslins of the finest sorts," "fine pearls, ivory, silk cloth" "crude glass", "coins", etc'., apart from many other commodities that were exported from India. Other western historians, and traveller-adventurers like Megasthanes, Strabo, Ptolemy, Fa Hien, Huen Tsang, Pliny, Marco Polo, Al Beruni, Ibn Batuta, etc., have also enumerated the various commodities that were produced and exported by India

- Another instance of Indian metallurgy is the copper statue of Gautama Buddha found at Sultan Ganj in Bihar. The statue is 2.13 metres high and weighs nearly a tonne. There are many such examples that bear testimony to the excellence in smelting metals achieved in India in ancient times



A panel from Khajuraho
Note the intricate and fine outline of the figurines carved. The temples were completed over a period of 200 years

In this picture a clubbing of Buddhist statues and Hindu statue has taken place. The front image of Goddess Durga is flanked by four different statues of Buddha in her right and left. All the brass figurines are dazzling in the black background

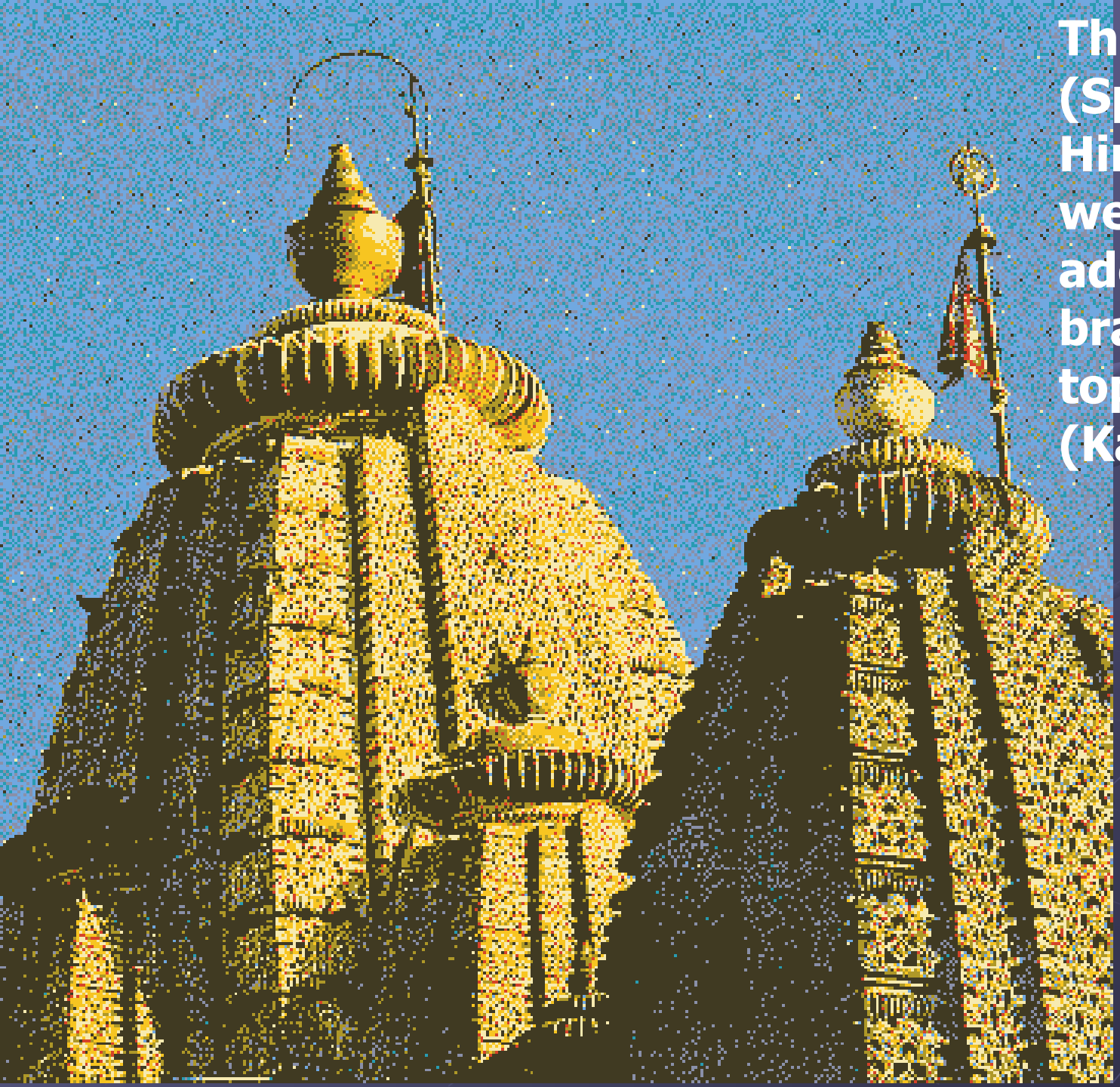
This picture is a collage of different Brass Buddha Statues. Displayed in the front right and left are the statues of Medicine Buddhas. The middle statue is that of Bhumisparsha Buddha while in the back are two simple Buddha statues in different postures. These brass statues are dazzling in the black background

Metallurgy was an important activity the world over. In fact the discovery of smelting of metals made possible the progress of society from the Stone Age to the Bronze and Iron Ages. In the area of smelting metals, Indians had acquired proficiency in the extraction of metals from ore, and also in the casting of metals. In very early times: around 2000 B.C

This image of Nataraja the God of Dance is made of five metals (Pancha-Dhatu)

This technology of mixing two or more metals and deriving superior alloys has been observed and noted by the Greek Historian Philostratus

- An instance of Indian metallurgy is the copper statue of Gautama Buddha found at Sultan Ganj in Bihar. The statue is 2.13 metres high and weighs nearly a tonne. There are many such examples that bear testimony to the excellence in smelting metals achieved in India in ancient times



The Makara (Spire) over Hindu temples were always adorned with brass or gold toppings (Kamandalas).

This mirror work dates back to the12th Century A.D. Smelting of metals and derivation of alloys was done since 3000 B.C. in ancient India

- From very early times the construction of temples, palaces, rest houses and other civil construction was undertaken by professional architects known as Sthapati. Even during the Vedic times, there existed professionals who specialised in the technique of constructing chariots and other heavy instruments of war. These professionals have been referred to in the Rig Veda as Rathakaara which literally means 'chariot maker'

- The excavations of the ruins at Mohenjodaro and Harrappa (today in Pakistan) proved the existence of a developed Urban civilisation in India. The Indus valley civilization is dated around 3000 BC Thus since the last 5000 years. India has had an urban civilisation. The existence of an urban civilization presumes the existence of well developed techniques of architecture and construction

- These techniques would no doubt have had been systematically stated in record books for transmitting them to the later generations as well for being used as reference media for actual construction. Unfortunately, as far as the Indus Valley civilization goes no such records have been preserved either as rock edicts, manuscripts, etc., or in folk tales and legends

The pillar, almost seven meters high and weighing more than six tons, was erected by Chandragupta II Vikramaditya (375 AD–414 AD), (interpretation based on analysis of archer type Gupta gold coins) of the Gupta dynasty that ruled northern India 320–540

- **The Iron Pillar at Delhi**
- The Iron Pillar at Delhi located near the Kutab Minar, is estimated to have been cast in the Gupta period i.e. about 1500 years ago. The Pillar is 7.32 metres in length, tapering from a diameter of 40 cms at the base to 30 cms, at the top and it weights about 6 tonnes. It has been standing in open for more than a millenium in the heat, dust and rain, but except for the natural erosion it has not caught rust. This kind of a rust-proof iron had not been smelted anywhere else in the world, till we invented the stainless steel a few decades ago

- Even if it is only **1600 years old**, the fact that it has withstood corrosion is remarkable when one compares with the iron beams used in temples of Puri and Konark which have undergone a high degree of rusting even though they are only about 700 years old.

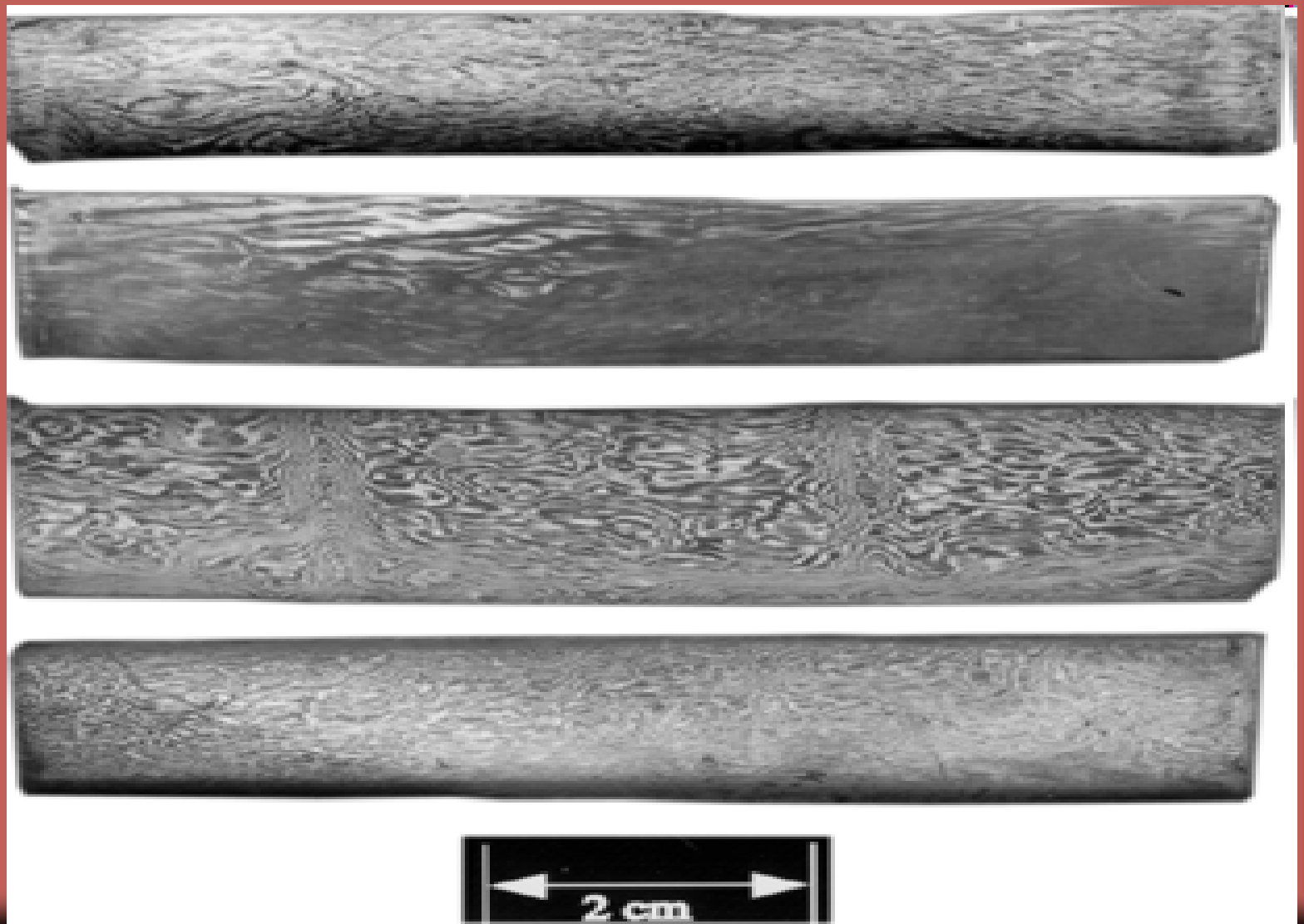
- Processing technique might have been different, but it is almost certain that either Pancake forging or Forge Welding technique was used in various forms for the pillars like that of Delhi (comparable ones being found in Dhar in Madhya Pradesh and Kodachadri in Karnataka), the length would have been vertically increased by raising the earthen platform around and constructing an extraction furnace of mud on top of the top end. The extracted sponge was probably hammered on in order to weld with the top, while heating was continued. Another procedure suggested is heating of the blooms in liquid lead metal followed by forge welding. But it is difficult to conceive how such a large mass could have been subjected to treatment of this type at that time.

- So, in brief, it can be concluded that the corrosion resistance property of the Delhi Pillar is due to: (i) the purity of its iron; (ii) high phosphorus; (iii) low sulphur; (iv) absence of any other metal; (v) cinder coating formed on the surface; (vi) better forge welding; (vii) drier and uncontaminated atmospheric condition; and (viii) mass metal effect

- The early Hindu astrologers are said to have used the magnet, in fixing the North and East, in laying foundations, and other religious ceremonies. The Hindu compass was an iron fish that floated in a vessel of oil and pointed to the North. The fact of this older Hindu compass seems placed beyond doubt by the Sanskrit word Maccha (Matsya) Yantra, or fish machine, which Molesworth gives as a name for the mariner's compass

- Methods for the extraction of metals like gold, silver, tin and copper from their ores and their purification are mentioned in Rasaratnakara. In an attempt to prepare the 'elixir of life' from mercury, Nagarjuna made use of animal and vegetable products, apart from minerals and alkalis. For the dissolution of diamonds, metals and pearls, he suggested the use of vegetable acids like sour gruel and juices of fruits and bark

Damascus Swords (Wootz)



Fine structure of Wootz Steel